Display System Having a Three-Dimensional Convex Display Surface; Inventors: STEVEN W. UTT et al.;
Docket No.: 23242-07464

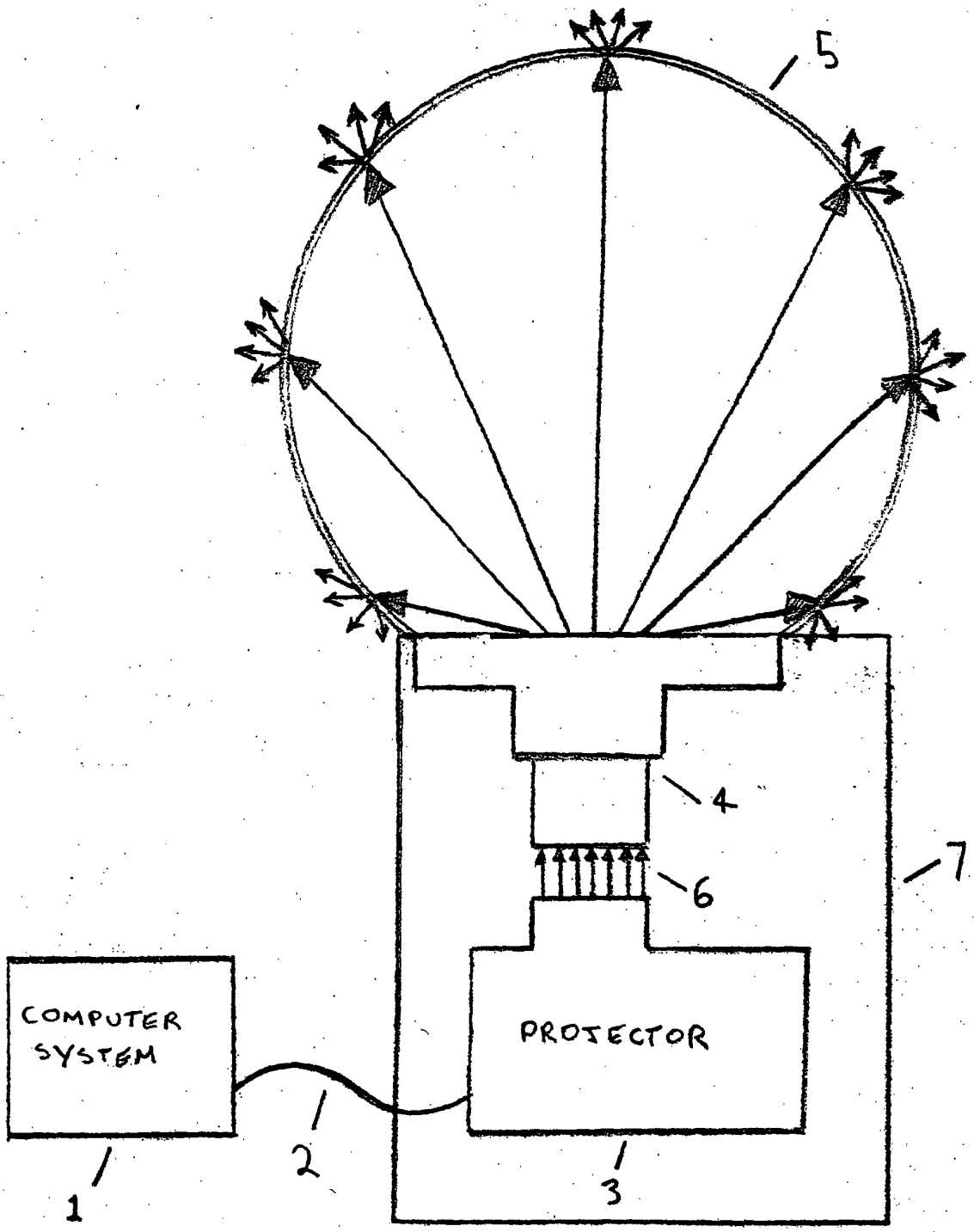

FIG. 1

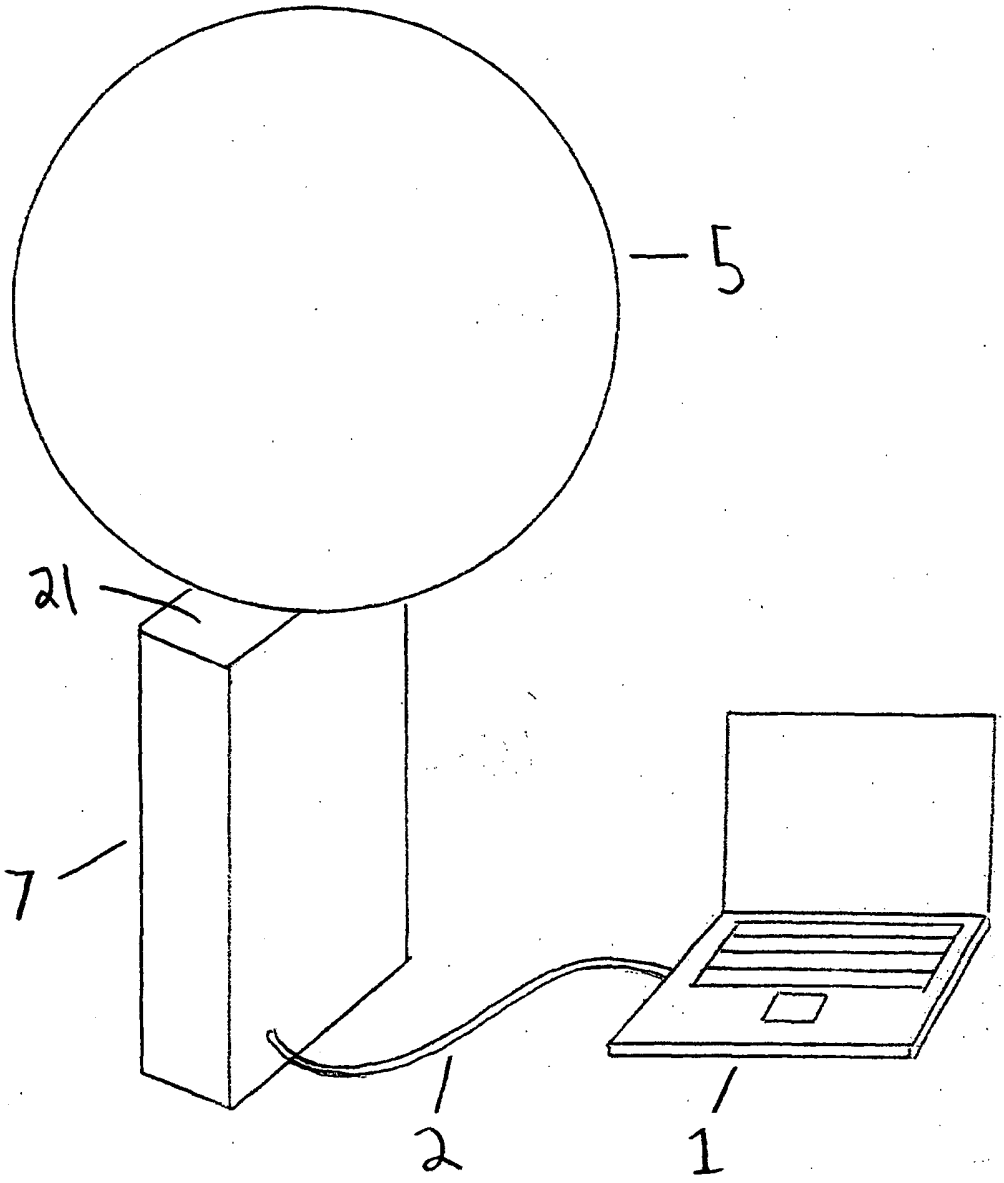

FIG. 2A

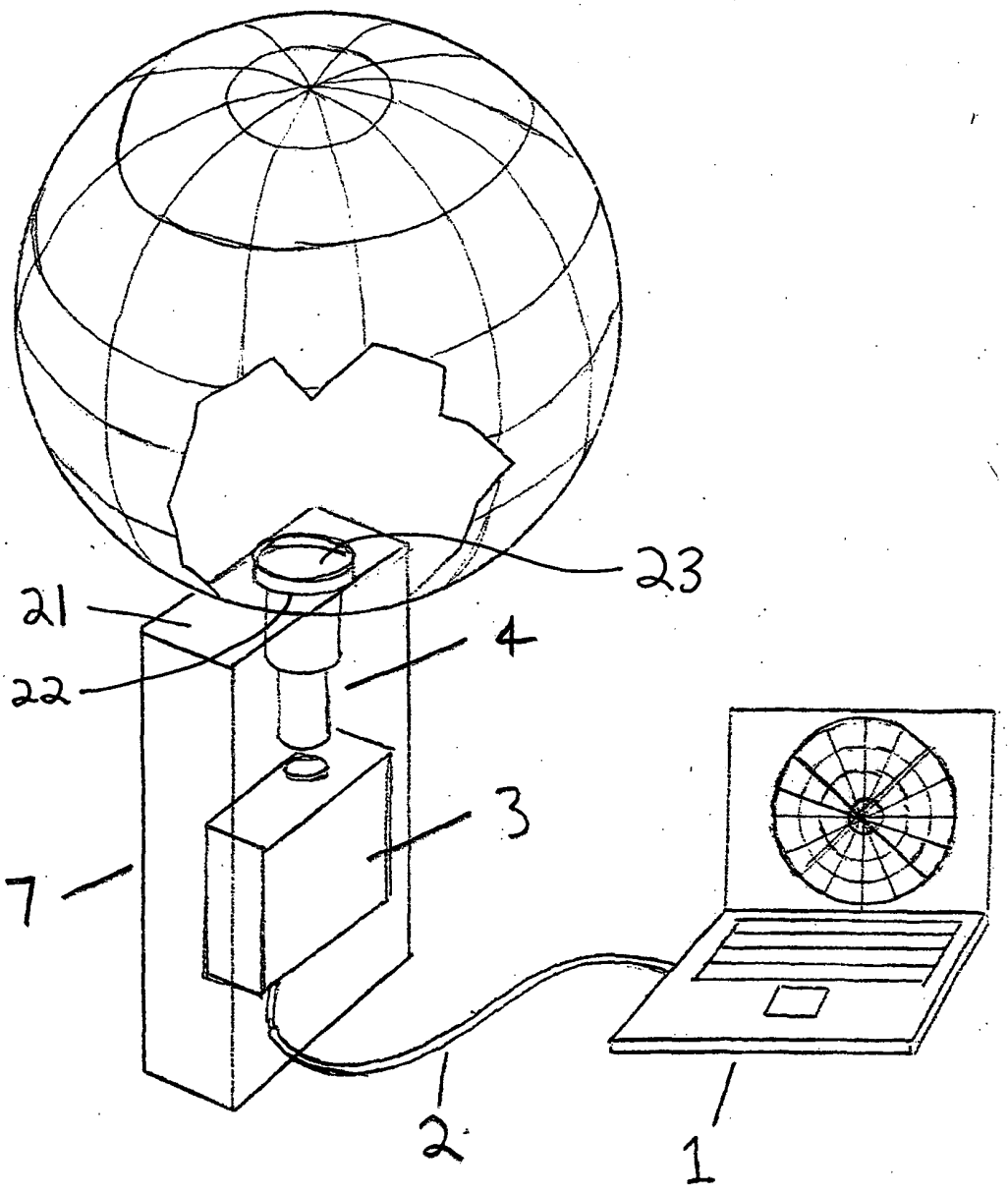

FIG. 2B

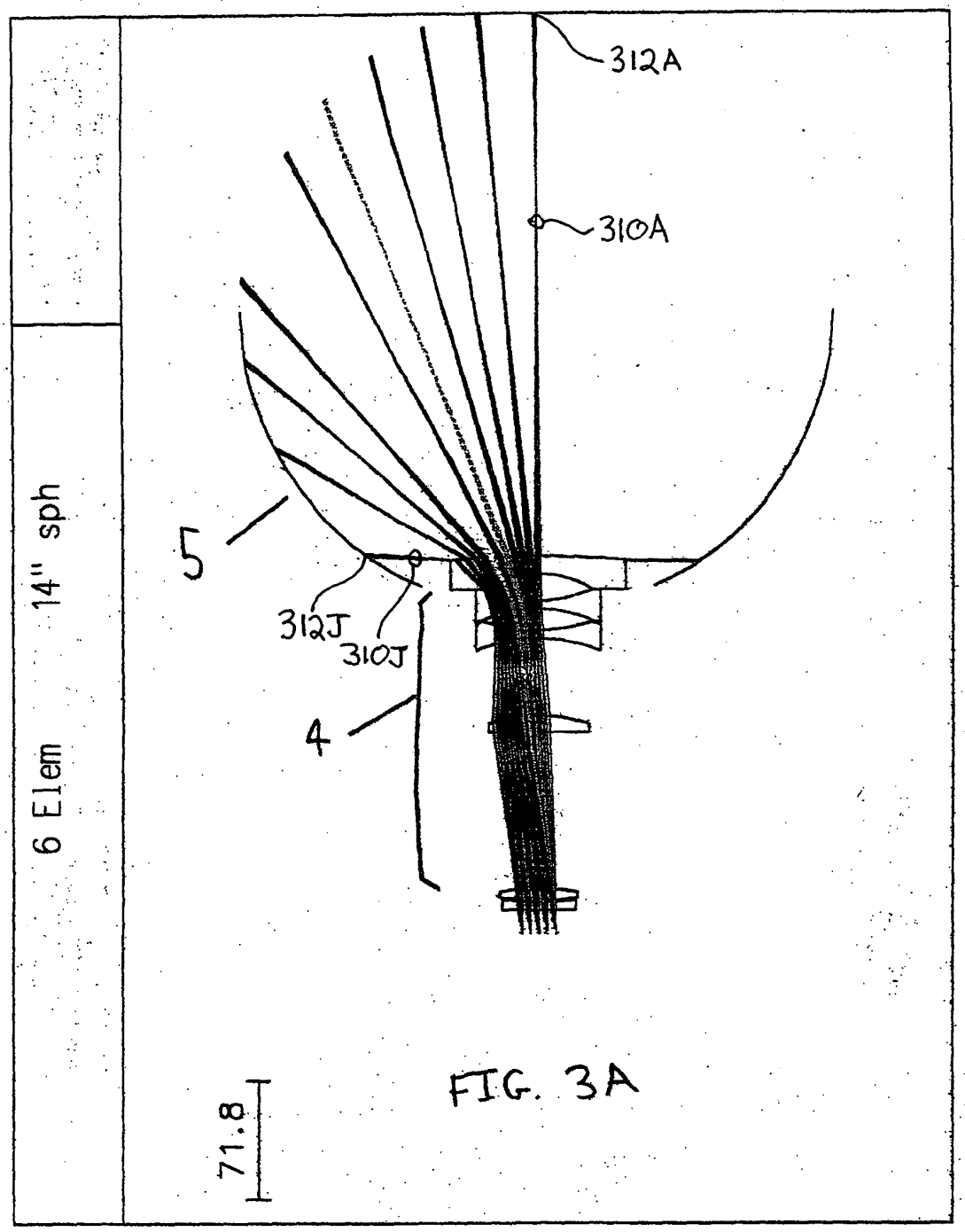

FIG. 3A

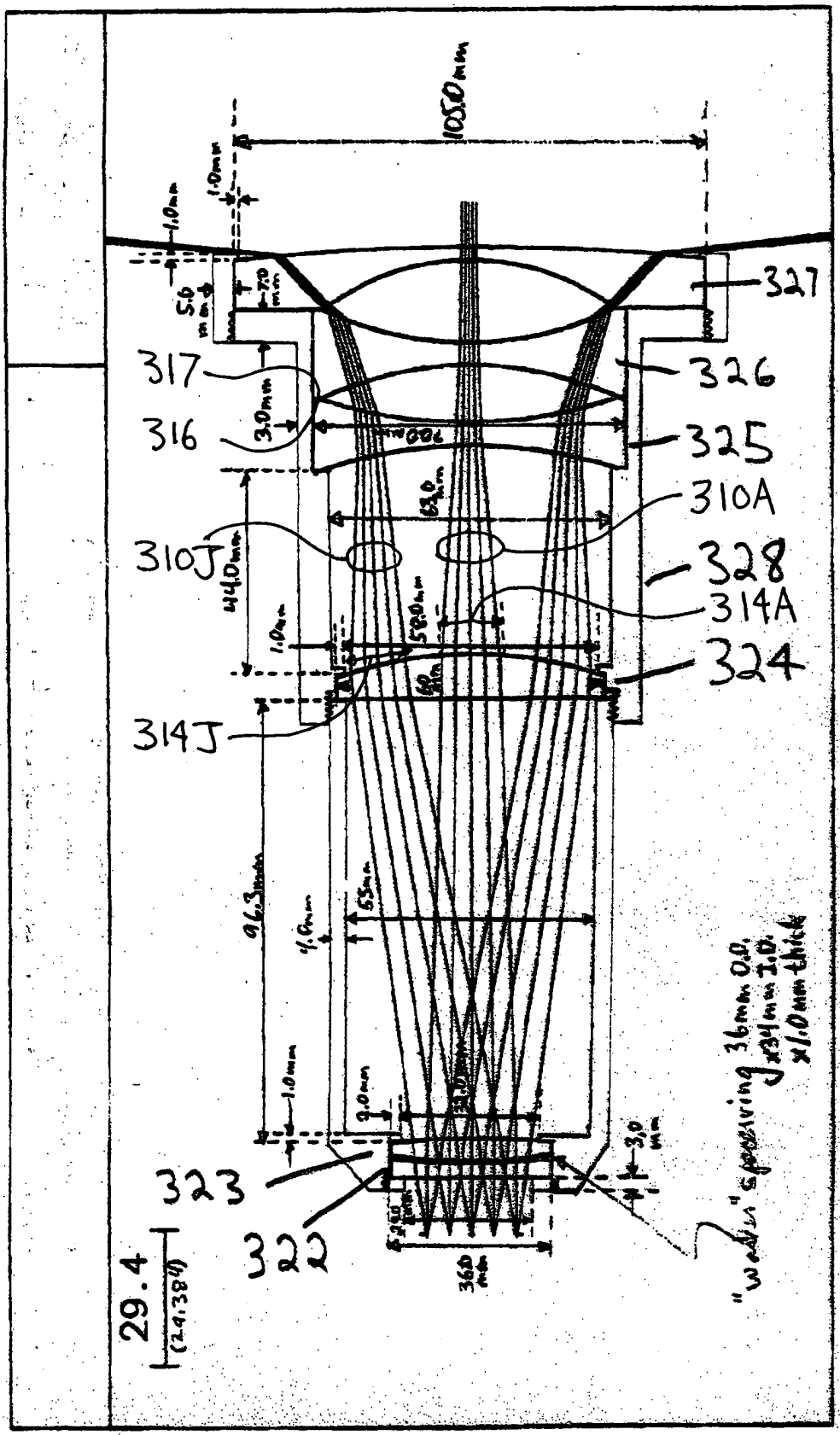
105.0mm
1.0mm
1.0mm
5.0mm
7.0mm
327
317
326
316
3.0mm
325
63.0mm
310A
310J
328
44.0mm
58.0mm
314A
1.0mm
324
314J
46.3mm
1.6mm
65mm
1.0mm
2.0mm
3.0mm
323
322
29.4
(24.138")
36.0mm
"wafer" to passing 36mm O.D. x 34mm I.D. x1.0mm thick

FIG. 3B

*LENS DATA

SRF	RADIUS	THICKNESS	APERTURE RADIUS		GLASS	SPE	NOTE
OBJ	--	-1.6000e+03	292.000000		AIR		
AST	--	13.000000	10.000000	A	AIR		
2	--	4.500000	22.000000		SF10	C	
JML 67891 PCV SF10							
3	168.268000	0.500000	22.000000	P	AIR		
4	122.680000	7.090000	23.240000		BK7	C	
JML 70552 DCX BK7							
5	-178.870000	94.518476	V 23.240000	P	AIR		
6	--	10.000000	30.000000		CARBO	C	
7	--	45.913584	V 30.000000		AIR		*
8	-103.950000	5.000000	37.500000		BK7	C	
Edm Sci 53115 DCV 75mm dia, -100 mm fl, Th 5mm?							
9	103.950000	P 13.000000	33.300000		AIR		
10	-78.000000	5.000000	37.500000		BK7	C	
Edm Sci 53114 DCV 75mm dia, -75mm FL, Th 3 mm							
11	78.000000	P 17.000000	32.800000		AIR		
12	-60.090000	10.320000	32.800000		LLF1	C	
JML 64015 Neg Meniscus LLF1							
13	-607.860000	-32.000000	52.500000		AIR		
IMS	177.800000	--	177.800000	X			*

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*SURFACE NOTES

2	JML 67891 PCV SF10
4	JML 70552 DCX BK7
8	Edm Sci 53115 DCV 75mm dia, -100 mm fl, Th 5mm?
10	Edm Sci 53114 DCV 75mm dia, -75mm FL, Th 3 mm
12	JML 64015 Neg Meniscus LLF1

*ASPHERIC SURFACE DATA

7	ASP	ASR	10 - SYMMETRIC GENERAL ASPHERE						
	AS0	--	AS1	-0.005597	AS2	4.4030e-08	AS3	--	
	AS4	--	AS5	--					

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*SURFACE TAG DATA

14	ASI	1
	DRW	ON

*REFRACTIVE INDICES

SRF	GLASS	RN1	RN2	RN3	VNBR	TCE
0	AIR	1.000000	1.000000	1.000000	--	--
1	AIR	1.000000	1.000000	1.000000	--	236.000000
2	SF10	1.728250	1.746482	1.720848	28.409716	75.000000
3	AIR	1.000000	1.000000	1.000000	--	236.000000
4	BK7	1.516800	1.522376	1.514322	64.166410	71.000000
5	AIR	1.000000	1.000000	1.000000	--	236.000000
6	CARBO	1.585469	1.599220	1.579900	30.303790	--
7	AIR	1.000000	1.000000	1.000000	--	236.000000
8	BK7	1.516800	1.522376	1.514322	64.166410	71.000000
9	AIR	1.000000	1.000000	1.000000	--	236.000000
10	BK7	1.516800	1.522376	1.514322	64.166410	71.000000
11	AIR	1.000000	1.000000	1.000000	--	236.000000
12	LLF1	1.548140	1.556547	1.544566	45.749335	81.000000
13	AIR	1.000000	1.000000	1.000000	--	236.000000
14	IMAGE SURFACE					

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*APERTURES

SRF	TYPE	APERTURE RADIUS
0	SPC	292.000000
1	SPC	10.000000
2	SPC	22.000000
3	PKP	22.000000
4	SPC	23.240000
5	PKP	23.240000
6	SPC	30.000000
7	SPC	30.000000
8	SPC	37.500000
9	SPC	33.300000

Table I

FIG. 3C

```
10      SPC     37.500000
11      SPC     32.800000
12      SPC     32.800000
13      SPC     52.500000
14      SPC    177.800000

     Special Aperture Group 0:
     A  ATP       Ellipse  AAC     Pass Thru  AAN       --
        AX1    -70.000000  AX2     70.000000  AY1   -70.000000  AY2     70.000000


*WAVELENGTHS
CURRENT   WV1/ww1      WV2/ww2      WV3/ww3
   1     0.587560     0.486130     0.656270
         1.000000     1.000000     1.000000

*PARAXIAL SETUP OF LENS
 APERTURE
   Entrance beam radius:      0.724036    Image axial ray slope:      0.010000
   Object num. aperture:      0.000453    F-number:                 -37.131424
   Image num. aperture:  *    0.010000    Working F-number:          50.000000
 FIELD
   Field angle:              10.342657    Object height:        *   292.000000
   Gaussian image height:   -13.213647    Chief ray ims height:      19.605736
 CONJUGATES
   Object distance:        -1.6000e+03    Srf 1 to prin. pt. 1:     358.025381
   Gaussian image dist.:     -55.481113   Srf 13 to prin. pt. 2:      0.720991
   Overall lens length:      225.842060   Total track length:     -1.4062e+03
   Paraxial magnification:    -0.045252   Srf 13 to image srf:       -32.000000
 OTHER DATA
   Entrance pupil radius:     0.724036    Srf 1 to entrance pup.:        --
   Exit pupil radius:         0.094539    Srf 13 to exit pupil:     -46.027214
   Lagrange invariant:       -0.132136    Petzval radius:            54.277855
   Effective focal length:  -53.768941
 SPOT DIAGRAMS
   Aperture divisions:        17.030000   Gaussian apod. spec.:      off
   X 1/e^2 entr. irrad.:       1.000000   Y 1/e^2 entr. irrad.:      1.000000
Note: This optical system contains special surface data.
      Calculations based on a paraxial raytrace may be invalid.
```

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FIG. 3C CONTINUED

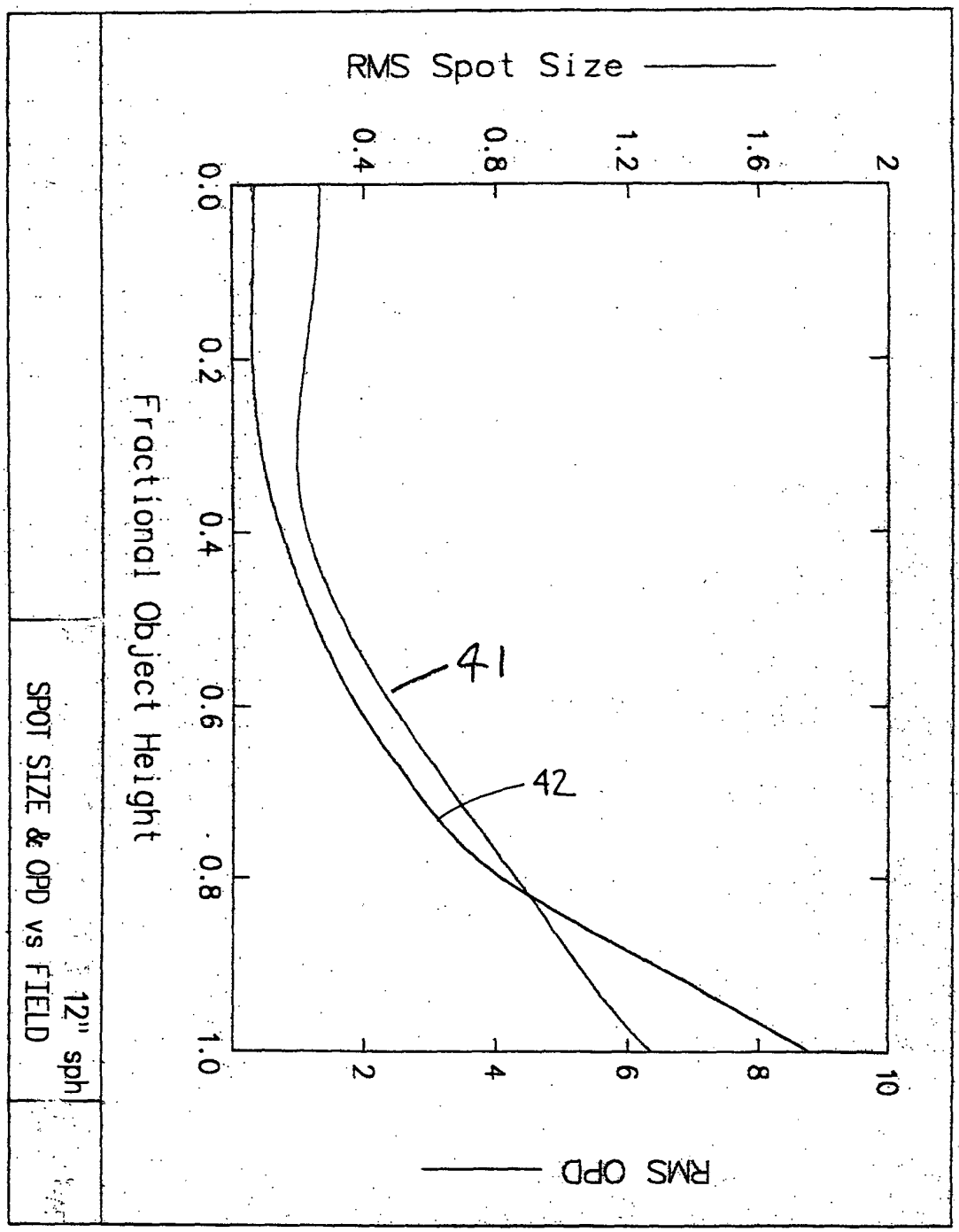
RMS Spot Size
0.4
0.8
1.2
1.6
2
0.0
0.2
0.4
0.6
0.8
1.0
Fractional Object Height
41
42
2
4
6
8
10
RMS OPD
SPOT SIZE & OPD vs FIELD
12" sph

FIG. 4A

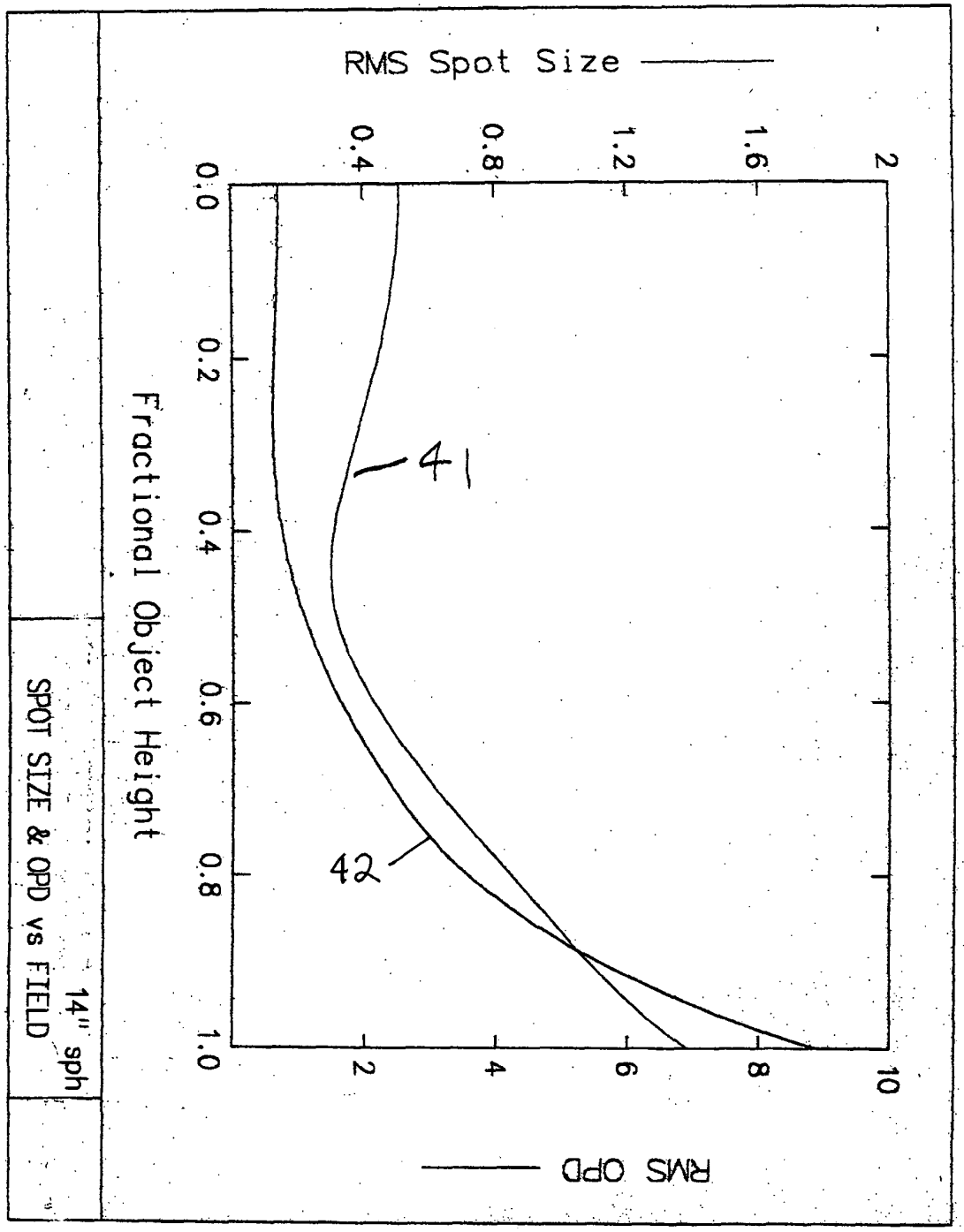
RMS Spot Size
0.4
0.8
1.2
1.6
2
0.0
0.2
0.4
0.6
0.8
1.0
Fractional Object Height
41
42
2
4
6
8
10
RMS OPD
SPOT SIZE & OPD vs FIELD
14" sph

FIG. 4B

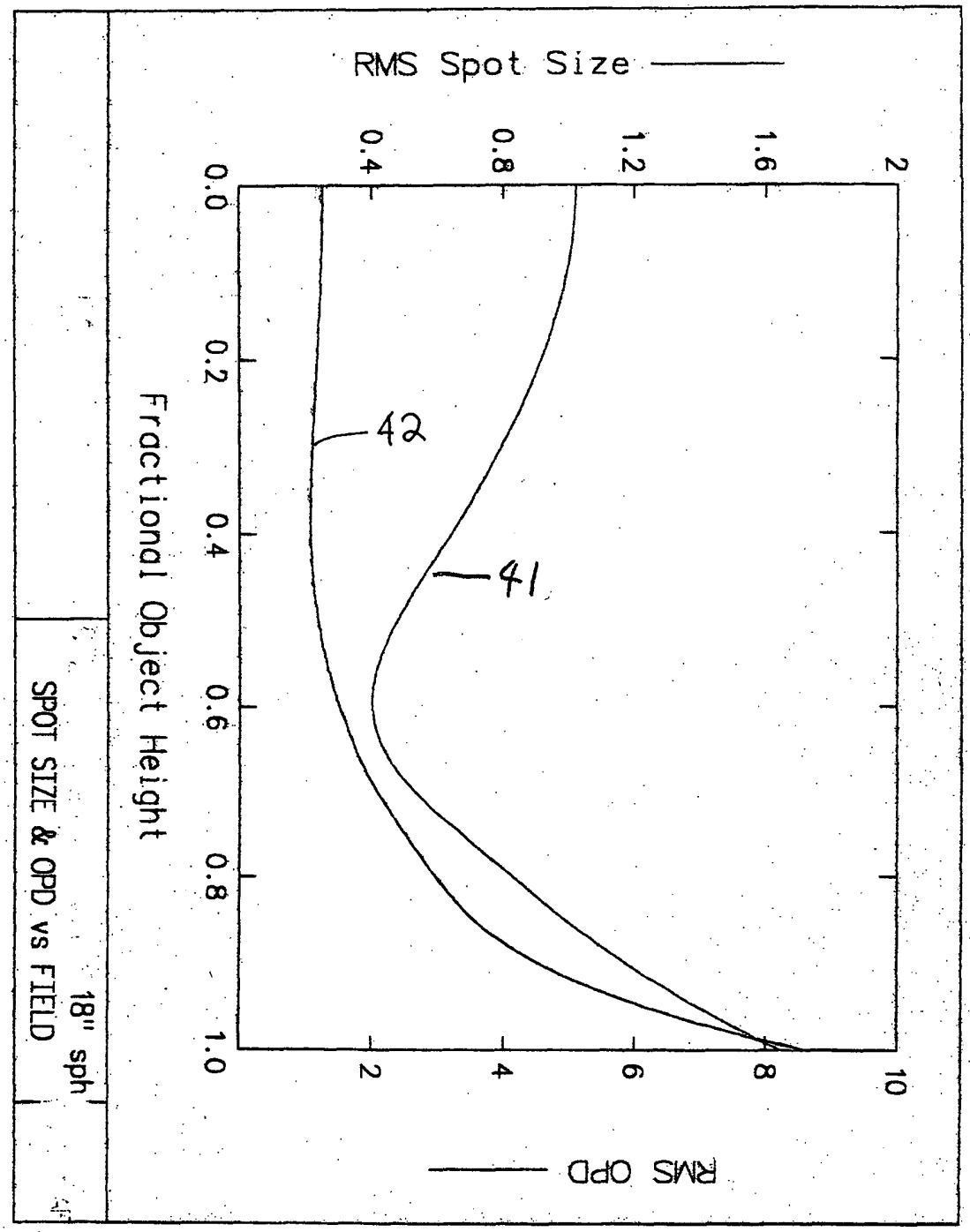
RMS Spot Size
0.4
0.8
1.2
1.6
2
0.0
0.2
0.4
0.6
0.8
1.0
42
41
Fractional Object Height
2
4
6
8
10
RMS OPD
SPOT SIZE & OPD vs FIELD
18" sph

FIG. 4C

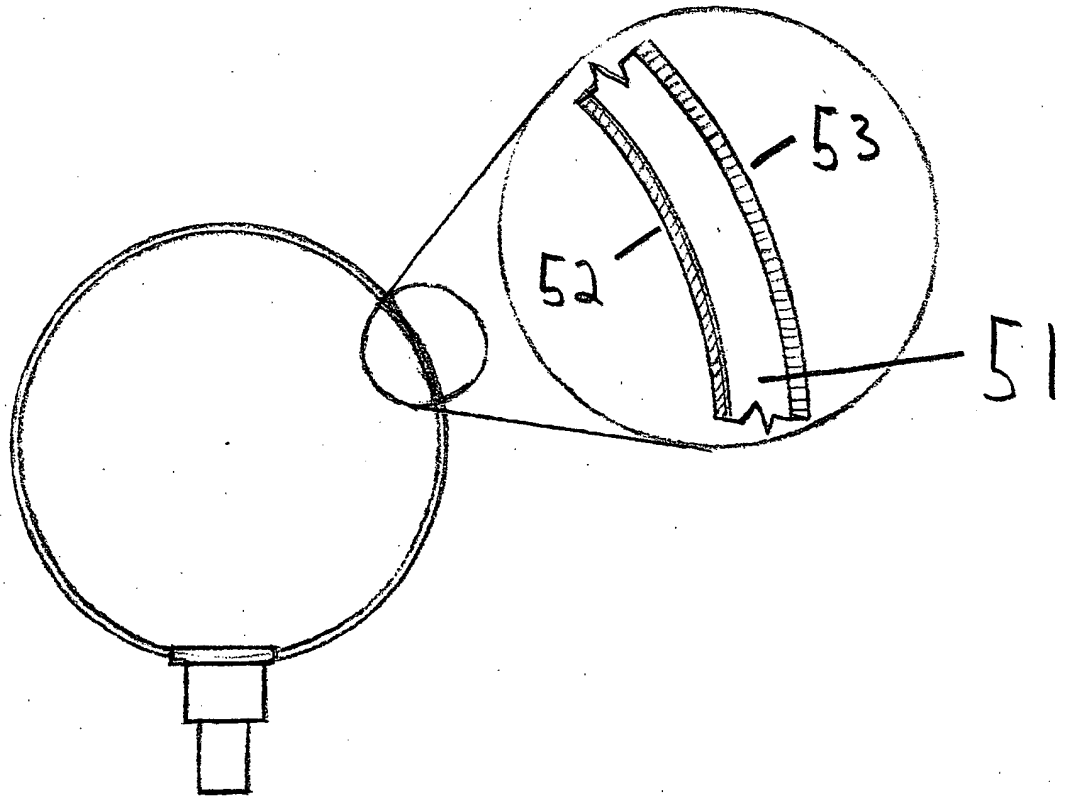

FIG. 5

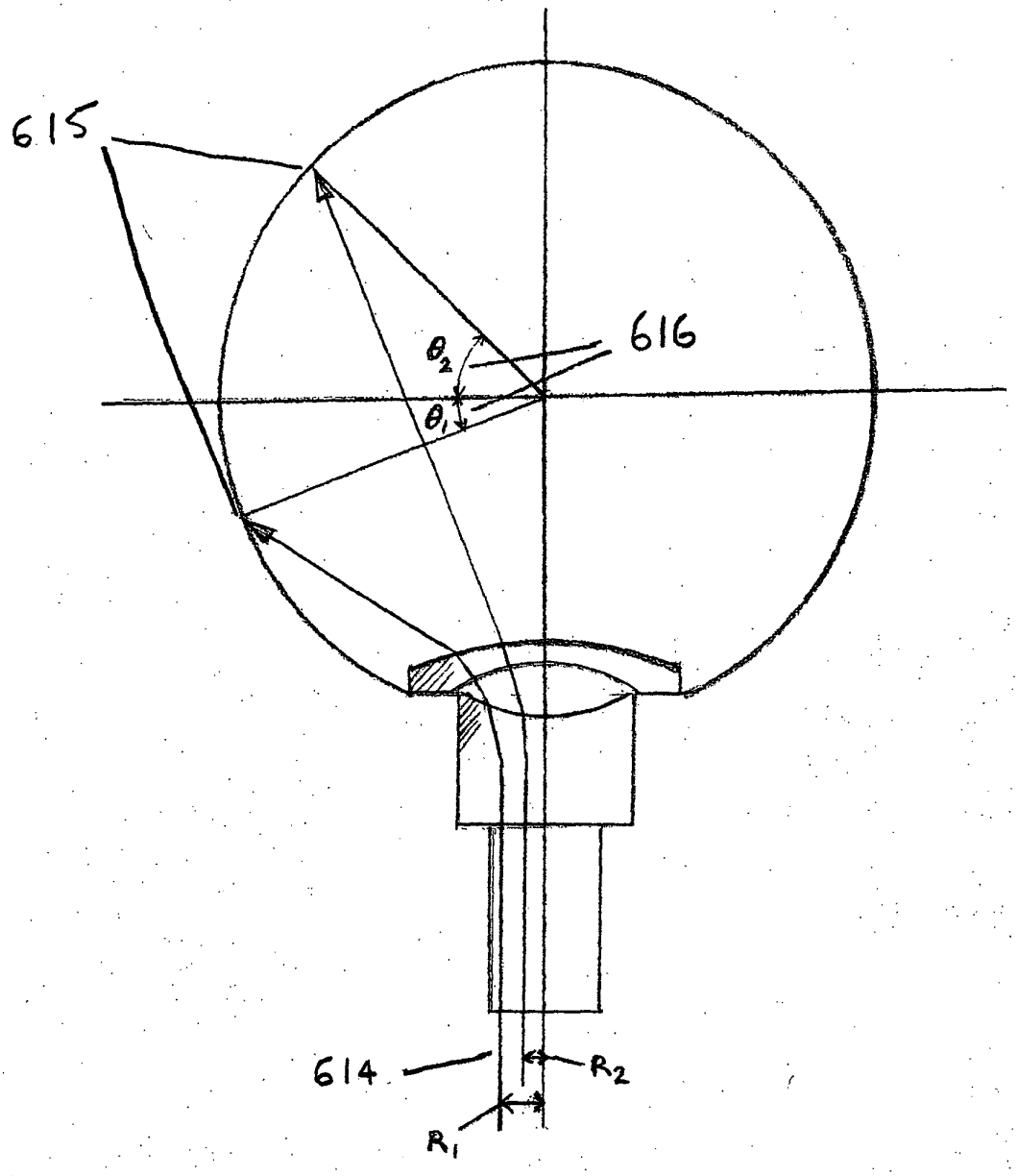

FIG. 6A

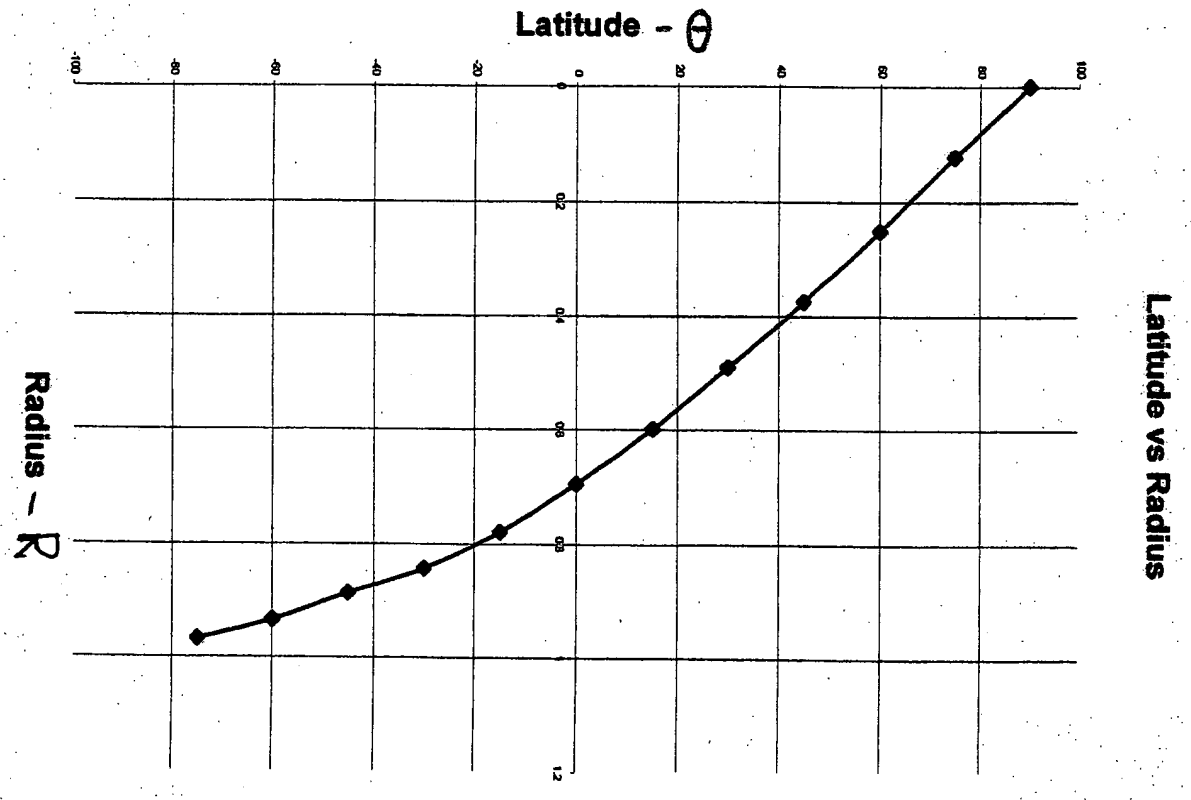

FIG. 6B

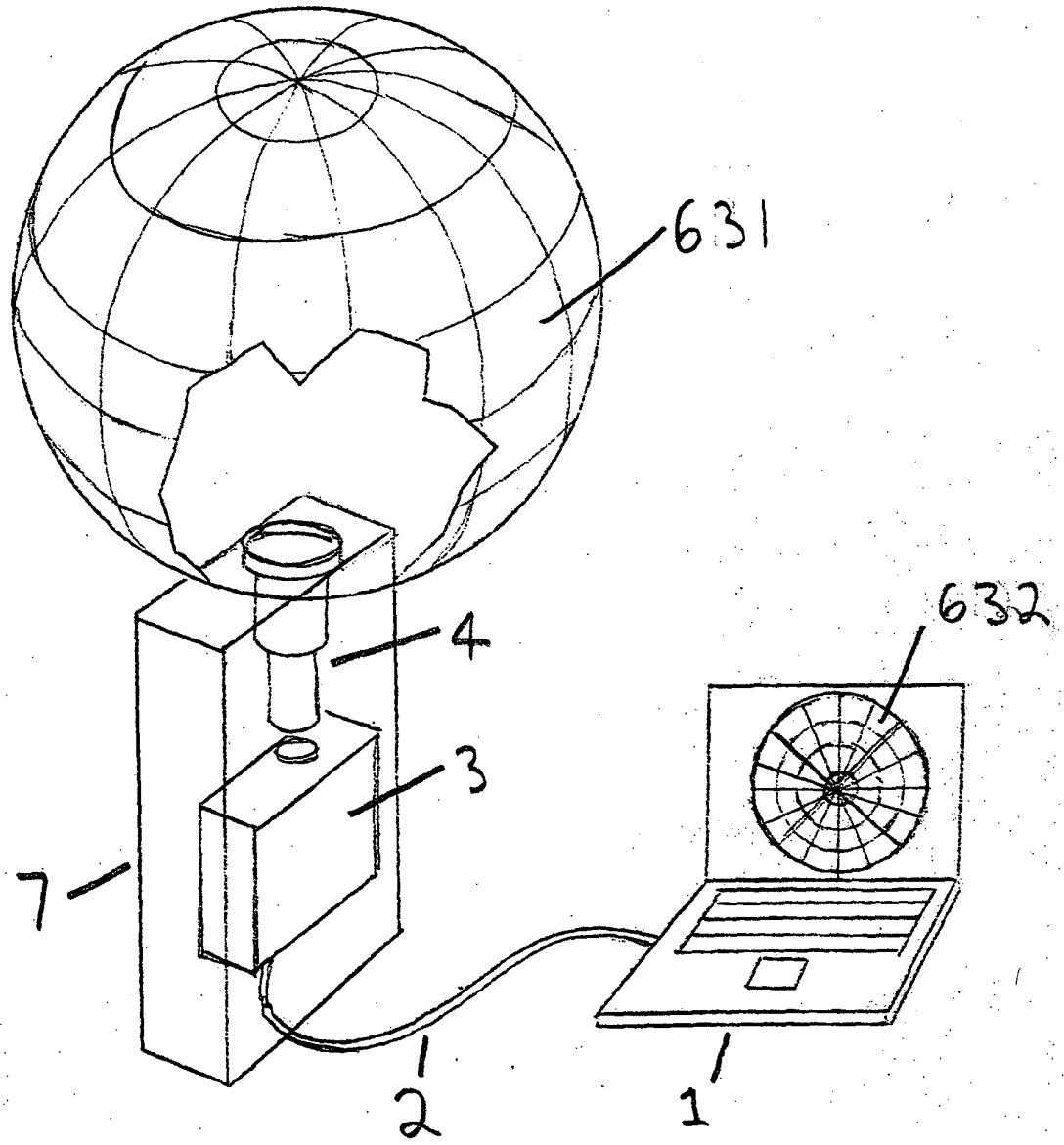

FIG. 6C

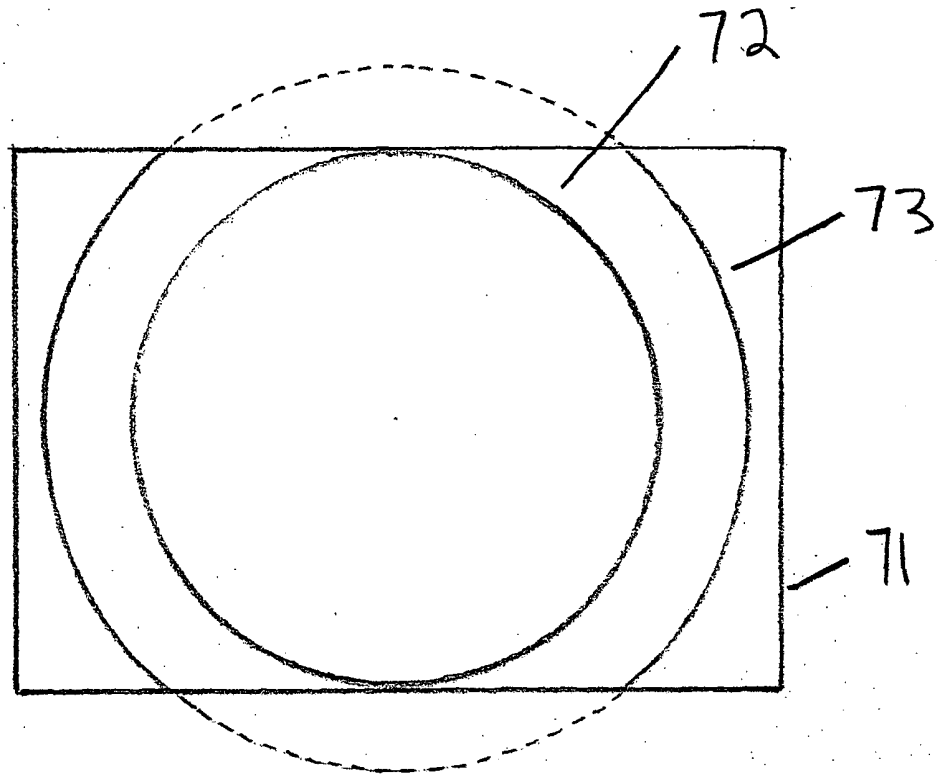

FIG. 7

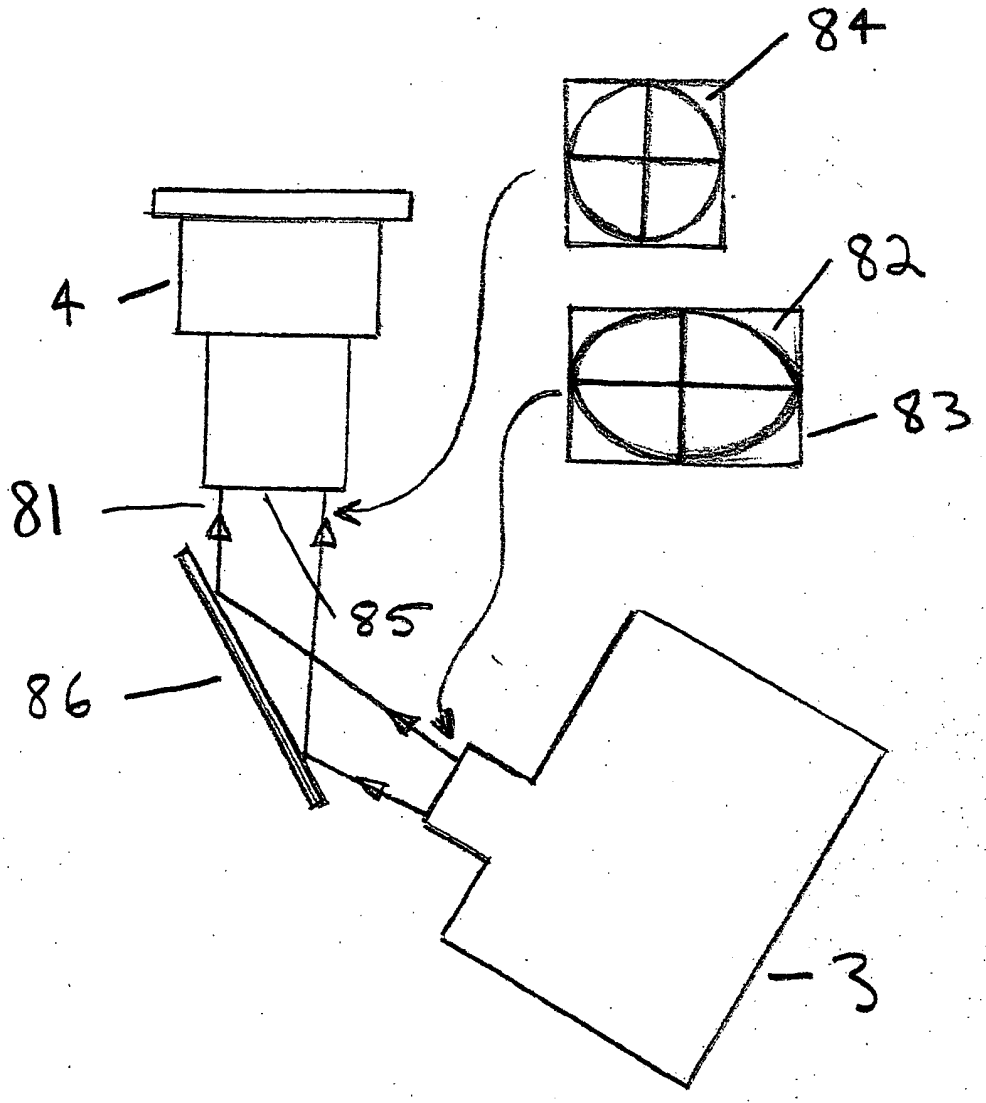

FIG. 8

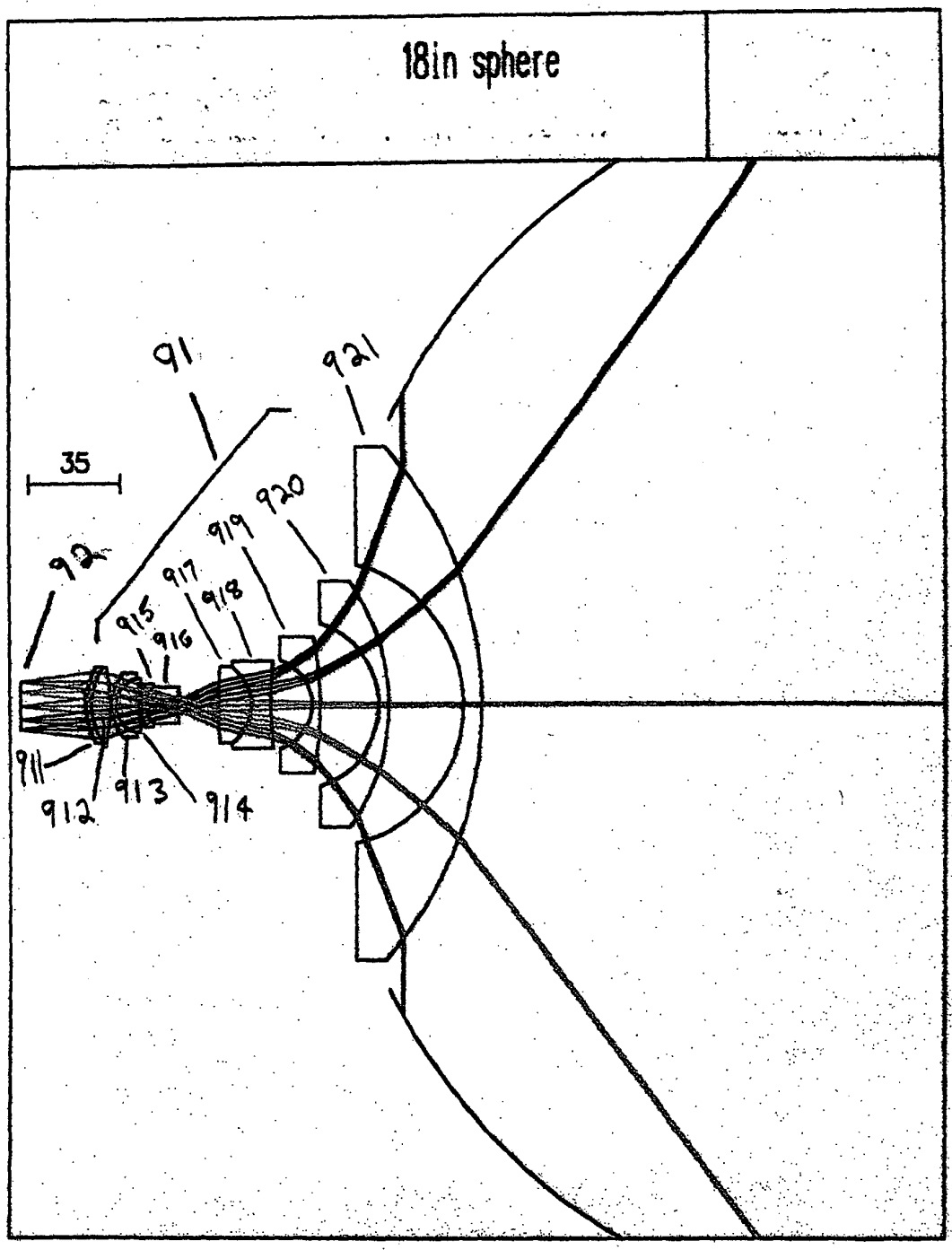

FIG. 9A

*LENS DATA
181n sphere

SRF	CURVATURE	THICKNESS	APERTURE RADIUS	GLASS	SPE	NOTE
OBJ	--	24.700800	9.000000	AIR	*	
1	0.032916 V	2.000000	14.000000	SF1	C	
2	0.037270 V	6.999999 V	14.000000	SK11	C	
3	-0.017675 V	0.500000	14.000000	AIR		
4	0.054772 V	1.600000	11.000000	LAFN7	C	
5	0.096657 V	8.762197 V	10.000000	KF3	C	
6	0.007371 V	0.500000	10.000000	AIR		
7	0.042506 V	2.000000	8.000000	SF11	C	
8	0.098204 V	12.000000	8.000000	KF3	C	
9	0.010972 V	1.400000	8.000000	AIR		
AST	--	13.800000	2.875605 AS	AIR		
11	0.005249 V	12.600000	14.000000	SF10	C	
12	-0.058288 V	7.000000	14.000000	SK16	C	
13	0.006234 V	15.500000	16.000000	AIR		
14	-0.058480	3.000000	16.300000	BK7	C	
15	-0.008000	21.800000	25.000000	AIR		
16	-0.031725	3.800000	30.000000	BK7	C	
17	-0.013089	28.000000	45.000000	AIR		
18	-0.019048	7.000000	51.000000	BK7	C	
19	-0.006970	-60.000000	95.000000	AIR		
IMS	0.004374	--	230.000000 X		*	

*REFRACTIVE INDICES

SRF	GLASS	RN1	RN2	RN3	VNBR	TCE
0	AIR	1.000000	1.000000	1.000000	--	--
1	SF1	1.717360	1.734621	1.710313	29.511275	81.000000
2	SK11	1.563840	1.570284	1.561010	60.795650	65.000000
3	AIR	1.000000	1.000000	1.000000	--	236.000000
4	LAFN7	1.749502	1.764639	1.743193	34.948736	53.000000
5	KF3	1.514540	1.521099	1.511692	54.699656	81.000000
6	AIR	1.000000	1.000000	1.000000	--	236.000000
7	SF11	1.784720	1.806455	1.779987	25.755289	61.000000
8	KF3	1.514540	1.521099	1.511692	54.699656	81.000000
9	AIR	1.000000	1.000000	1.000000	--	236.000000
10	AIR	1.000000	1.000000	1.000000	--	236.000000
11	SF10	1.728250	1.746482	1.720847	28.408719	75.000000
12	SK16	1.620410	1.627557	1.617271	60.320455	63.000000
13	AIR	1.000000	1.000000	1.000000	--	236.000000
14	BK7	1.516800	1.522376	1.514322	64.163927	71.000000
15	AIR	1.000000	1.000000	1.000000	--	236.000000
16	BK7	1.516800	1.522376	1.514322	64.163927	71.000000
17	AIR	1.000000	1.000000	1.000000	--	236.000000
18	BK7	1.516800	1.522376	1.514322	64.163927	71.000000
19	AIR	1.000000	1.000000	1.000000	--	236.000000
20	IMAGE SURFACE					

*APERTURES

SRF	TYPE	APERTURE RADIUS
0	SPC	9.000000
1	SPC	14.000000
2	SPC	14.000000
3	SPC	14.000000
4	SPC	11.000000
5	SPC	10.000000
6	SPC	10.000000
7	SPC	8.000000
8	SPC	8.000000
9	SPC	8.000000
10	OBP	2.875605
11	SPC	14.000000
12	SPC	14.000000
13	SPC	16.000000
14	SPC	16.300000
15	SPC	25.000000
16	SPC	30.000000
17	SPC	45.000000
18	SPC	51.000000

FIG. 9B

```
19     SPC    95.000000
20     SPC   230.000000

    Special Aperture Group 0:
    A  ATP       Ellipse  AAC     Pass Thru  AAN        --
       AX1  -105.000000  AX2   105.000000  AY1  -105.000000  AY2   105.000000


*WAVELENGTHS
CURRENT  WV1/WW1     WV2/WW2     WV3/WW3
   1    0.587560    0.486130    0.656280
        1.000000    1.000000    1.000000

*PARAXIAL SETUP OF LENS
 APERTURE
   Entrance beam radius: *     3.000000    Image axial ray slope:     -0.001528
   Object num. aperture:       0.120571    F-number:                2.4346e-19
   Image num. aperture:        0.001517    Working F-number:        329.596329
 FIELD
   Field angle:             5.1566e-18     Object height:        *    -9.000000
   Gaussian image height:   715.318127     Chief ray ims height:     -13.092823
 CONJUGATES
   Object distance:          24.700000     Srf 1 to prin. pt. 1:     -18.711634
   Gaussian image dist.:    418.643524     Srf 19 to prin. pt. 2:    -57.310580
   Overall lens length:     148.262197     Total track length:       112.962197
   Paraxial magnification:  -79.479792     Srf 19 to image srf:      -60.000000
 OTHER DATA
   Entrance pupil radius:   1.2146e+19     Srf 1 to entrance pup.:  1.0000e+20
   Exit pupil radius:        0.718294      Srf 19 to exit pupil:     -51.396622
   Lagrange invariant:      -1.093117      Petzval radius:          -100.672057
   Effective focal length:   5.913958
 SPOT DIAGRAMS
   Aperture divisions:      32.000000      Gaussian apod. spec.:      off
   X 1/eA2 entr. irrad.:     1.000000      Y 1/eA2 entr. irrad.:      1.000000
 Note: This optical system contains special surface data.
       Calculations based on a paraxial raytrace may be invalid.
```

FIG. 7B CONTINUED

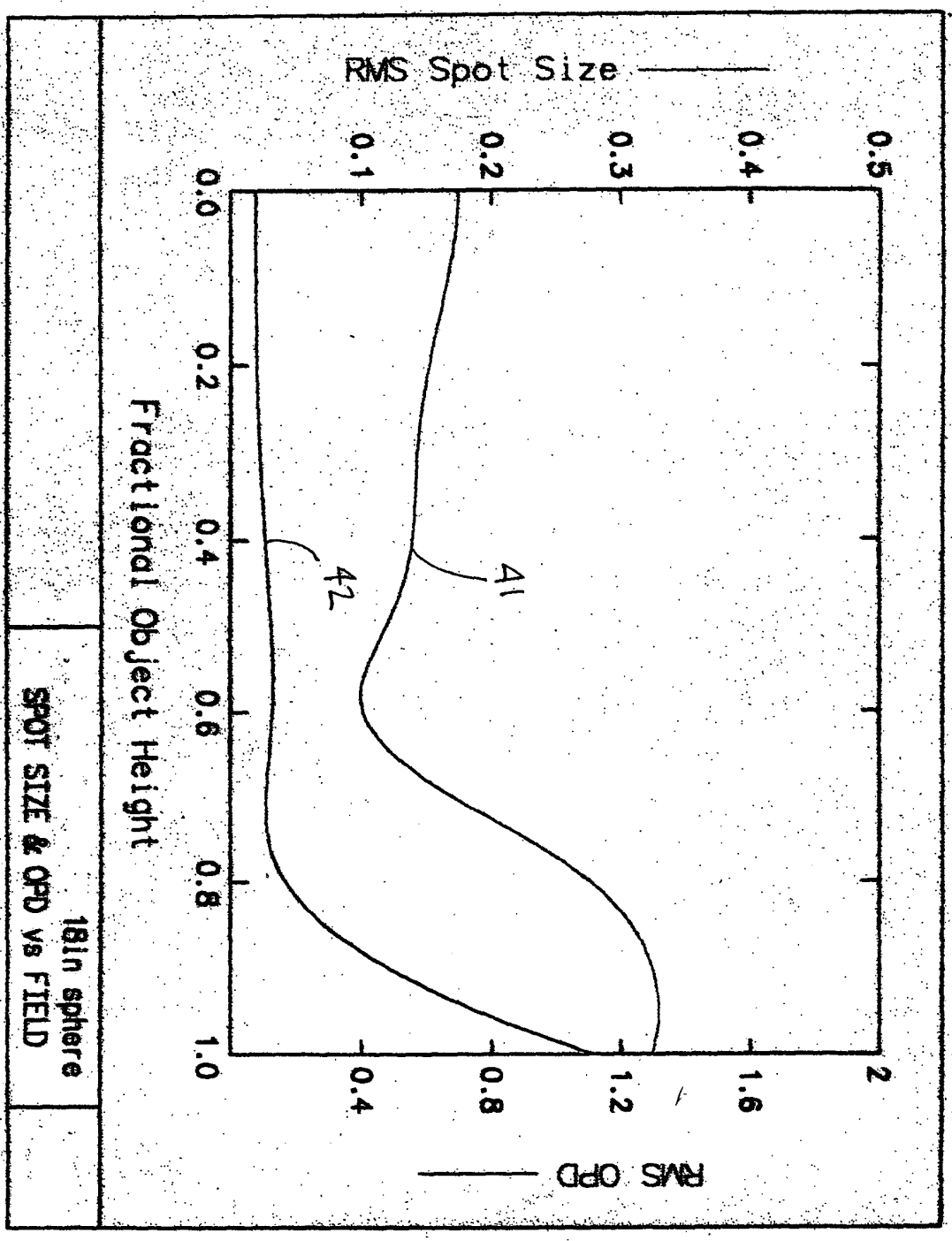
RMS Spot Size
0.1
0.2
0.3
0.4
0.5
0.0
0.2
0.4
0.6
0.8
1.0
Fractional Object Height
42
41
0.4
0.8
1.2
1.6
2
RMS OPD
18in sphere
SPOT SIZE & OPD vs FIELD

FIG. 9C

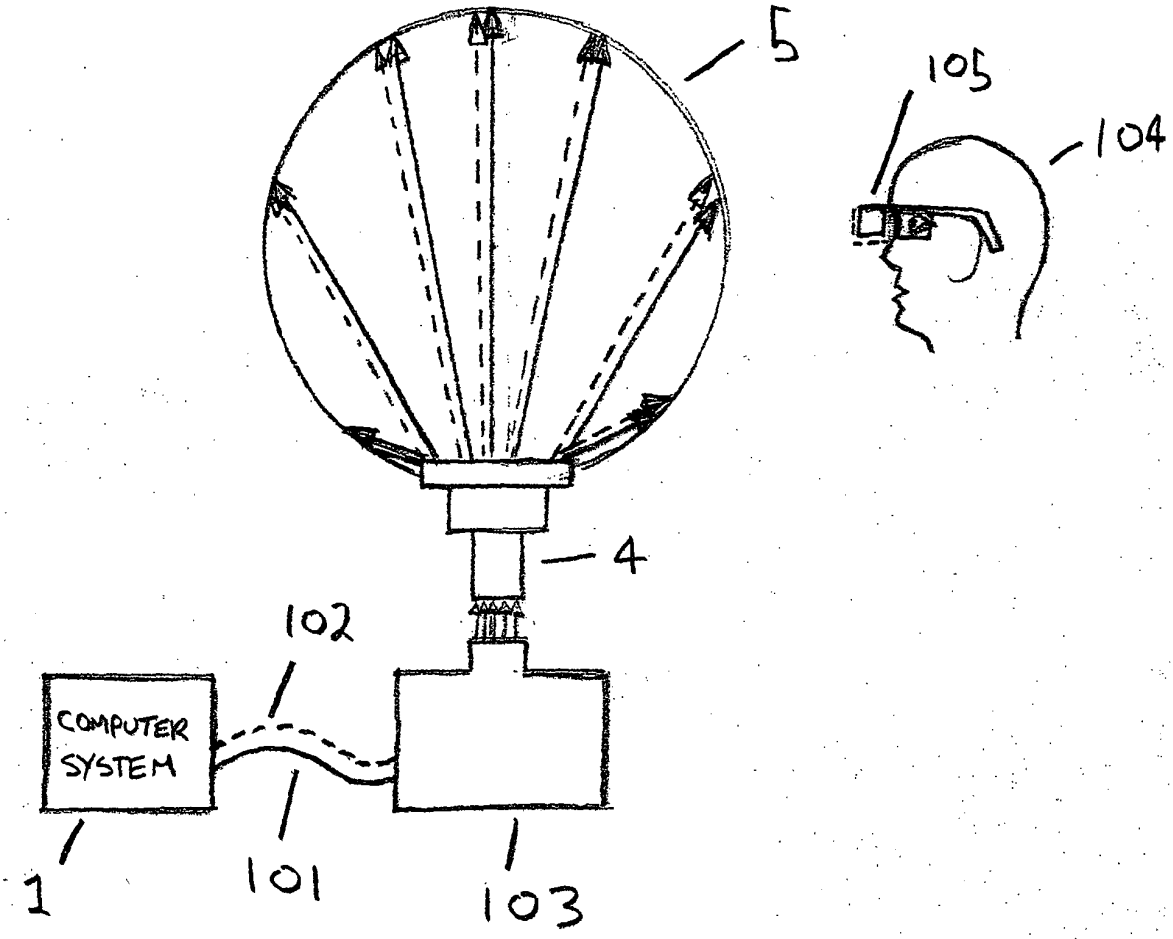

FIG. 10

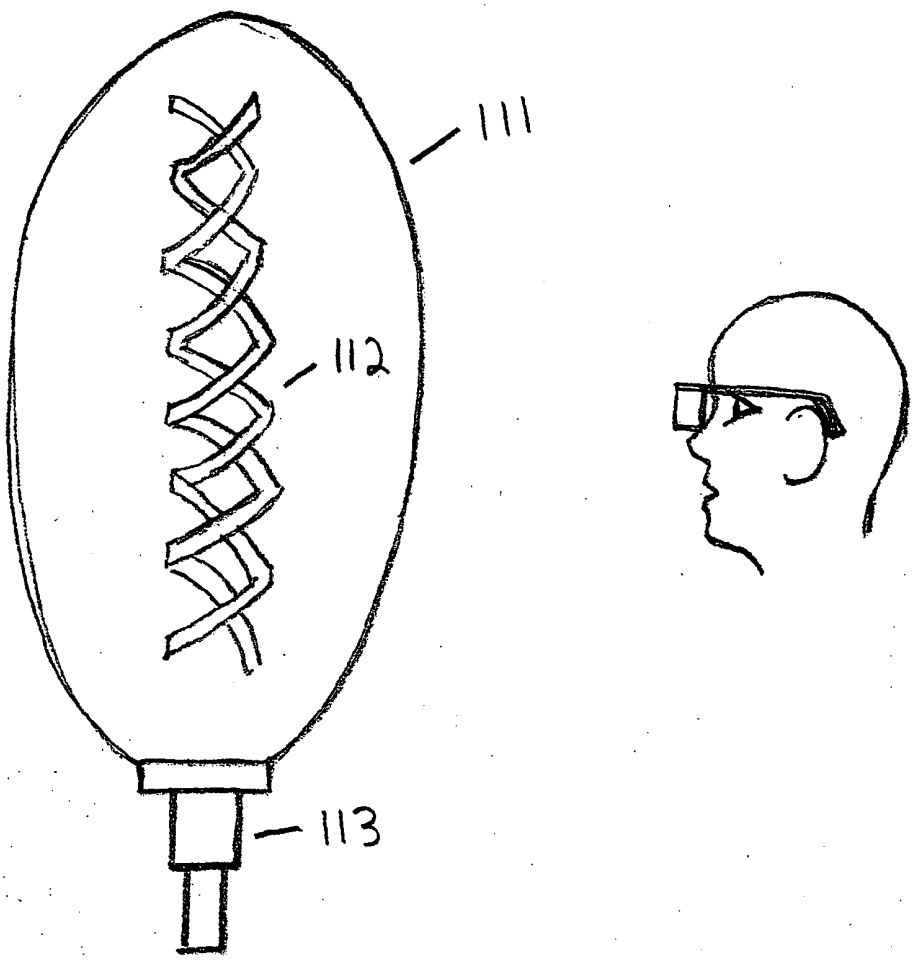

FIG. 11A

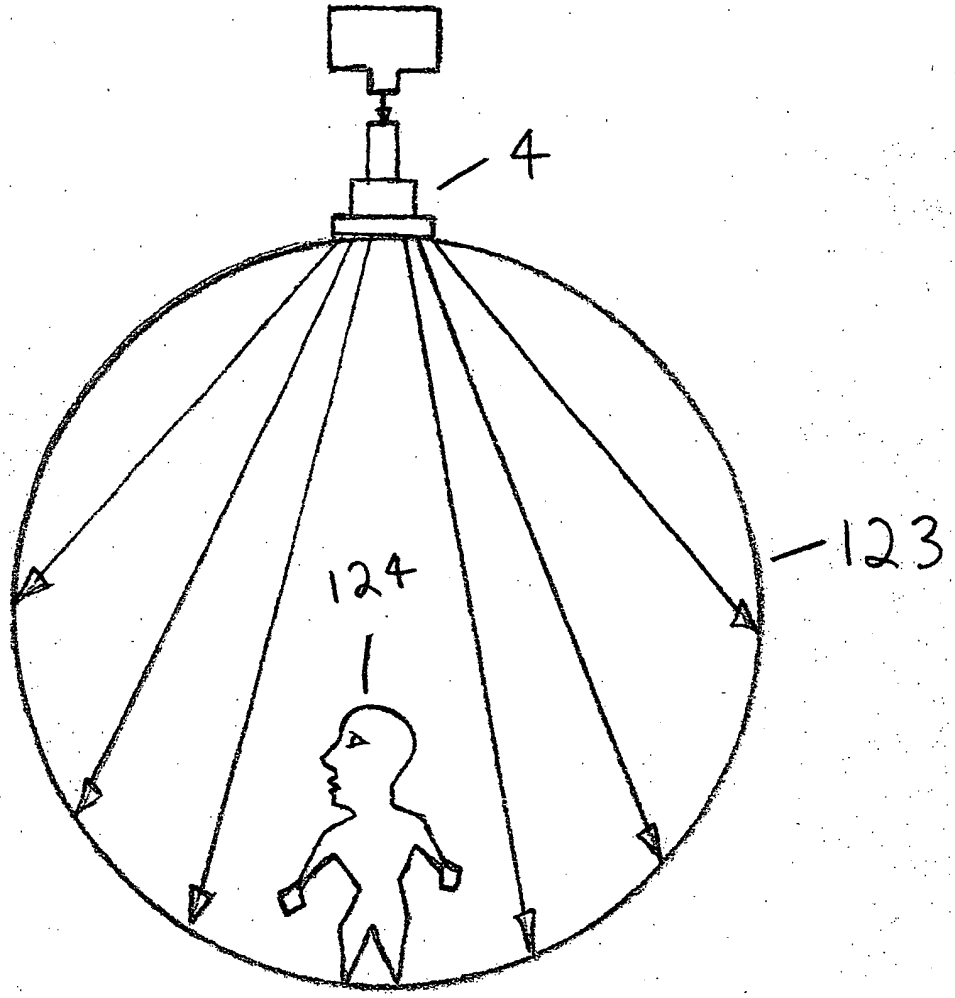

FIG. 11B

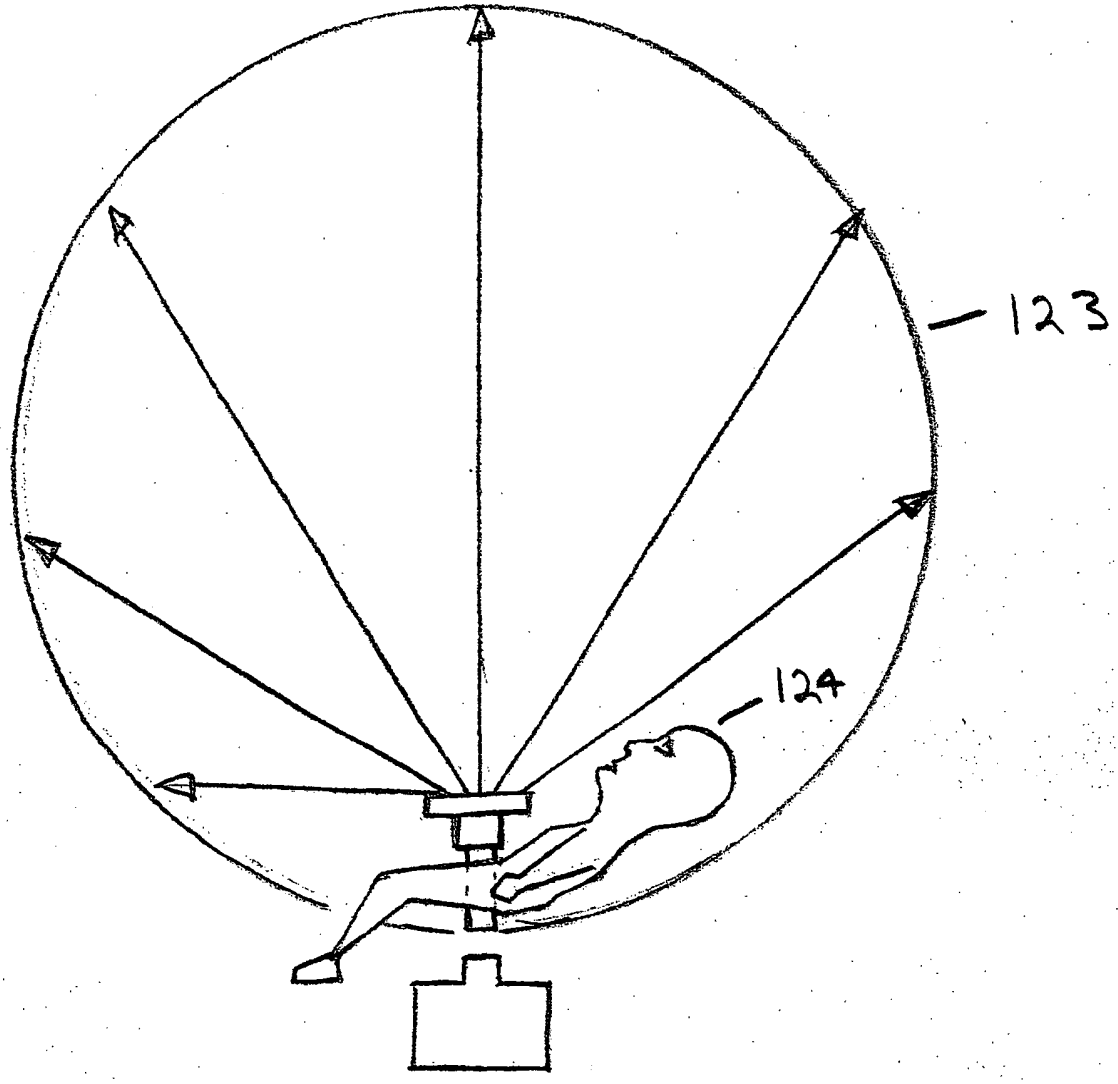

FIG. 11C

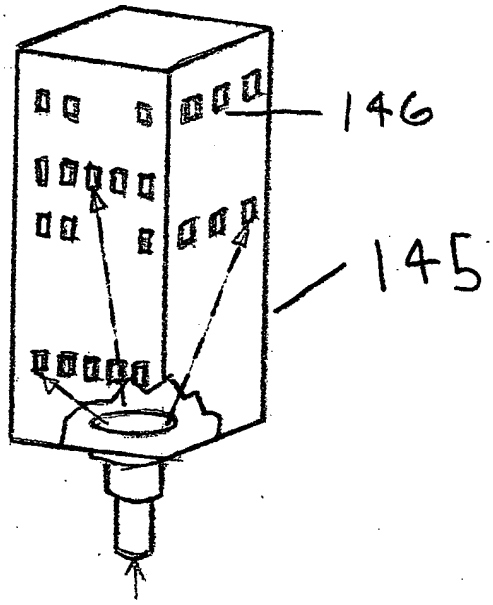

FIG. 11D

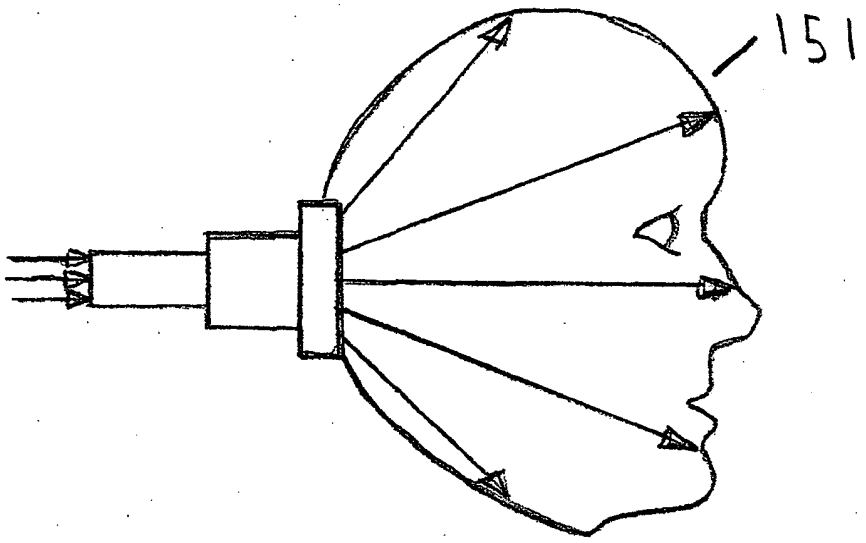

FIG. 11E

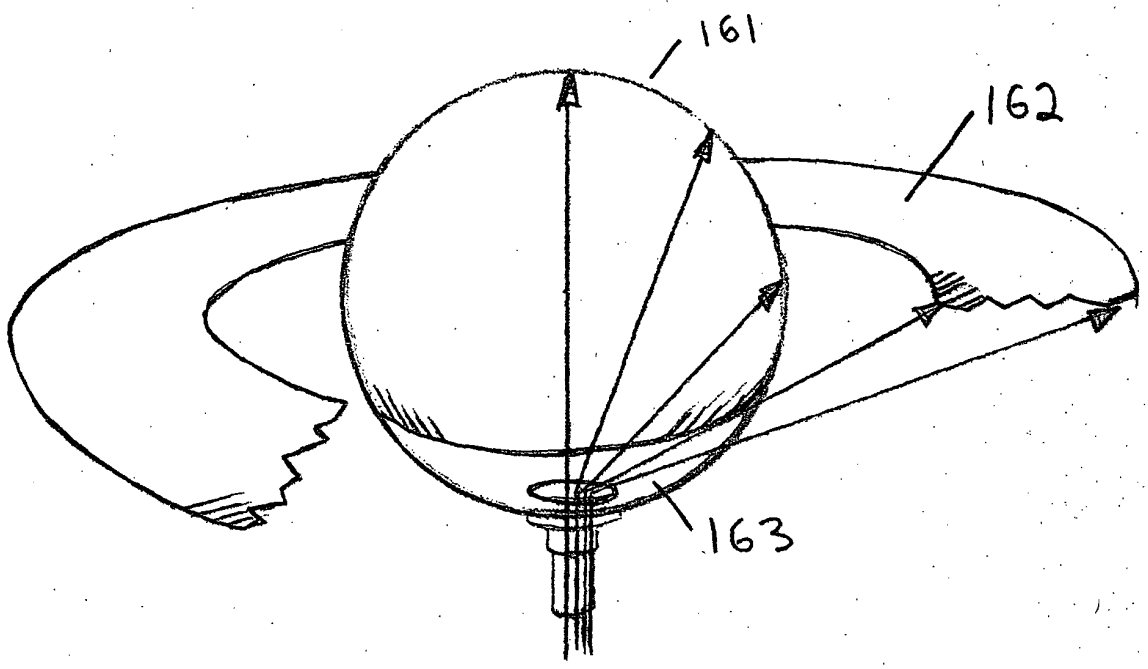

FIG. 11F

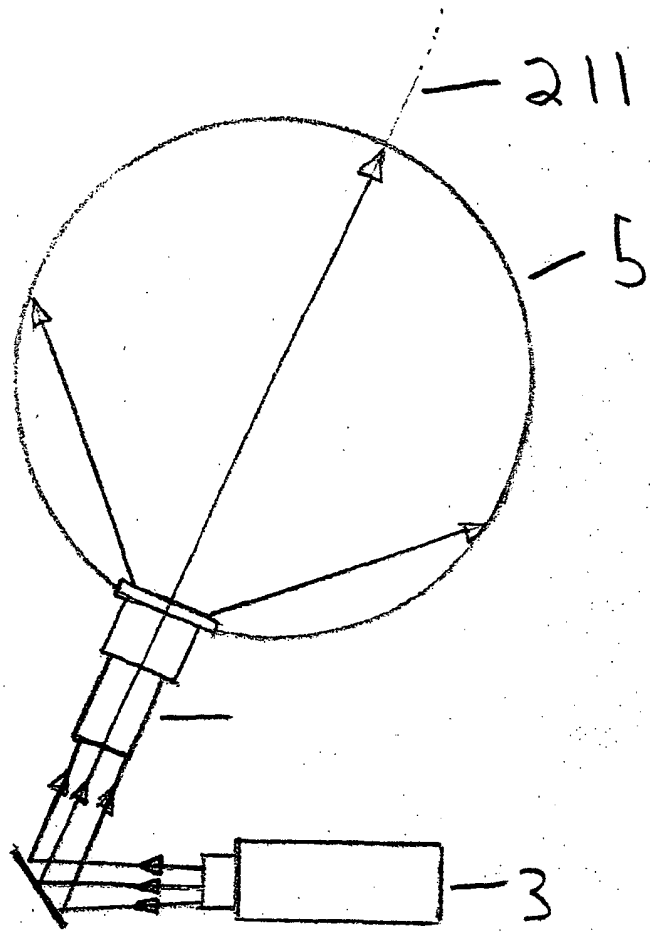

FIG. 12A

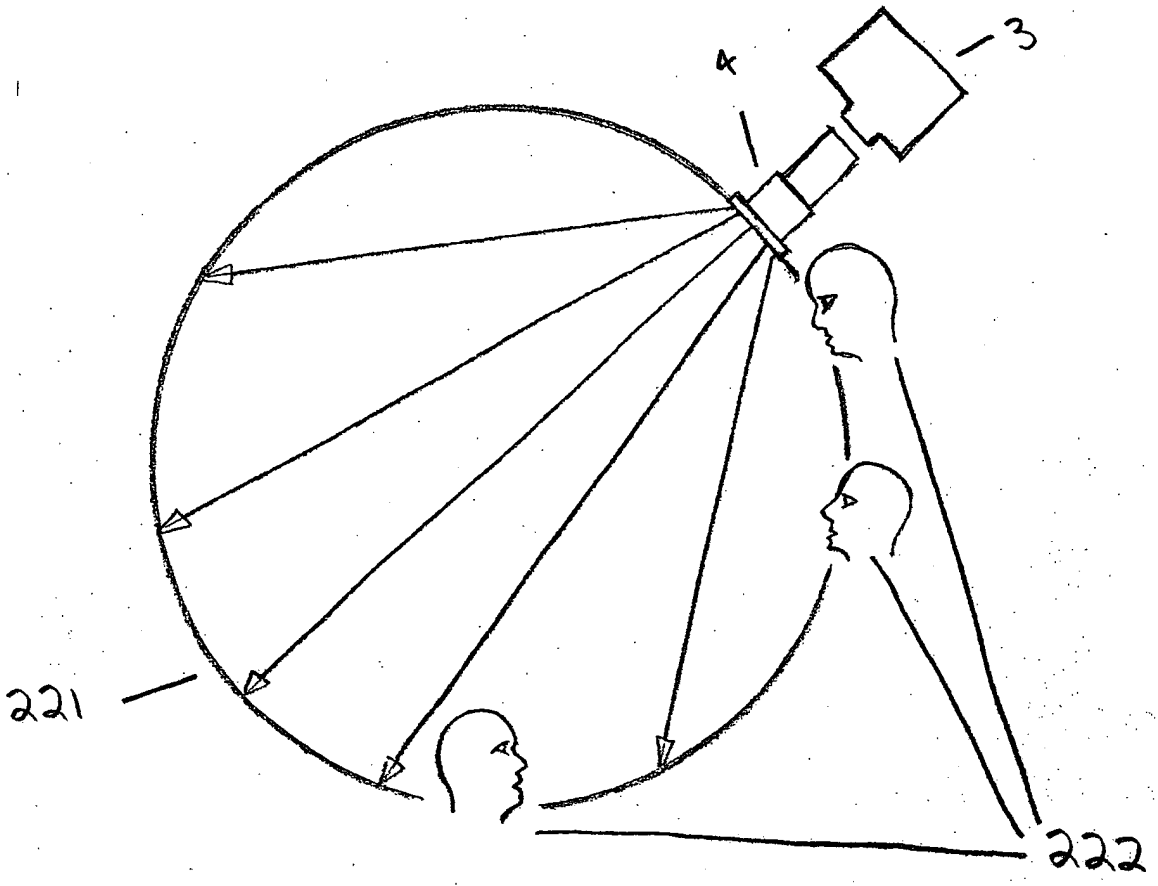

FIG. 12B

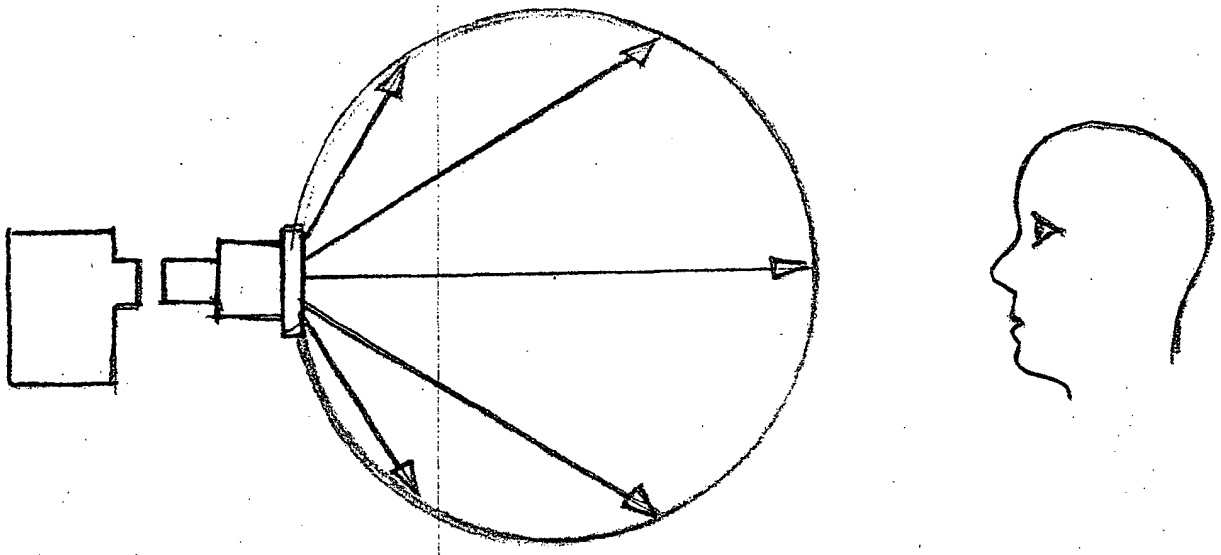

FIG. 12C